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Dr Edwin P. Rood
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Dear Dr Rood

Research in Nonlinear Water Waves
Navy Grant No. N00014-89-J-1164

Quarterly letter progress report July 1, 1990 - Sept 30, 1990

As Dr Reischman has left ONR, I assume that you are the appropriate scientific officer for this grant, and I am accordingly sending this quarterly letter report to you.

Satisfactory progress has been made with the continuing studies of the effect of a thin drift layer on the stability and shape of capillary gravity waves. The first part of the work has now been published in the Journal of Fluid Mechanics and appears to have aroused some interest. The second part on the stability of piecewise linear profiles has been accepted for publication in the same journal. The work was presented at an international meeting held in Warwick England last July and well received. It appears that there is considerable Russian effort in progress on closely similar problems. Some Russian scientists have expressed an interest in an extended visit to Caltech in order to carry out a cooperation on these and related problems, but I have had to inform them that funds are not available.

The problem mentioned in the last letter report about the counting for the integro-differential equation formulation of the shape of finite amplitude waves of permanent form has been resolved. The equations now seem to describe a well-posed problem, and the task now is to calculate solutions for problems of physical relevance. It is hoped that this will shortly get underway.

The calculation of stability for smooth profiles has been carried out, and the work is now being prepared for publication. This proved to be more difficult than anticipated but rather interesting. It uncovered new features of the way in which the Rayleigh equation (inviscid Orr-Sommerfeld equation) describes the onset of instability. We discovered to our surprise that the well known requirement for instability that there exist a point of inflection in the profile is not necessarily the case, and the case of shear flow profile with a free surface is a counter example. The work was also extended to three-dimensional disturbances, and it was shown that the Squire theorem still applies, so that the most unstable disturbances are two dimensional. Further studies of the results indicate that the new instabilities may not be closely relevant to the generation of waves by wind, as the surface drift velocities are not likely to be large enough. However, there is a possibility that there may be some relevance to situations where the shear layers are generated mechanically. This is a matter for further study.

Continuing studies on the Hamiltonian representation are in progress. A study of symplectic integrators for vortex dynamics, carried out under sponsorship of another agency, demonstrated that they seem to be very good for longtime integration. The problem with water waves is that we do not have canonical coordinates for waves that are not of small amplitude, and that an extension of the method for systems where the Poisson bracket is known but not the canonical coordinates is needed. Studies of this question were carried out during the summer, but the problem is hard and significant progress was not made. We do, however, have a canonical formulation for gentle waves, and numerical studies using a symplectic integrator will be carried out if resources are available. *Unfortunately*, the reduction in funding has impacted this aspect of the work.

Yours sincerely

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cc: ONR Pasadena
cc: Director, Naval Research Laboratory
cc: Defense Technical Information Center